Reliability and sensitivity of the 6 and 30 second Wingate tests in physically active males and females

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Abstract

BACKGROUND:

Despite widespread use of 6 and 30 second Wingate anaerobic tests (WAnT), performance reliability of these protocols over repeated trials in active males and females has not been determined.

OBJECTIVE:

This study assessed the performance reliability and test sensitivity of the 6 s and 30 s WAnT.

METHODS:

Twenty physically active participants (10 males and 10 females) completed a 6 s and 30 s WAnT against 7.5% body mass resistance on four occasions.

RESULTS:

Peak power output (PPO) and mean power output (MPO) did not differ across trials for either gender. Male PPO in both sprint durations demonstrated random variation (standard error of measurement (SEM)) ≤ 3.9% in all between-trials comparisons. For MPO, SEM was ≤ 2.9% in all comparisons. For females, random variation in PPO in both sprint durations was lower in trial 3-4 than earlier pairs of trials. MPO between trials in the 6-s sprint was variable, with the smallest variation between trials 1-2. For the 30-s sprint, MPO was more stable across trials. Across all four trials, only MPO in the 30-s test for males displayed good test sensitivity.

CONCLUSIONS:

In conclusion, familiarisation may not be required to establish consistent performance in physically active males or females during the 6 and 30 s WAnT. Furthermore, general marginal test sensitivity in both tests and genders suggests that results of WAnT in physically active participants should not be used to investigate the genuine effect of an intervention.

Keywords: *performance, testing, cycle, sprint, power*

1. Introduction

Performance reliability is defined as the consistency or reproducibility of a test over repeated trials in the same individuals [11]. Some inherent biological and technical variation in continuous measurements is expected [1]. Therefore, quantifying the degree of such variation is important when assessing the true performance change in research and practice [12]. To help address this, reliability studies should report the degree to which repeated measurements vary for individuals (relative reliability) and monitor changes over time (absolute reliability) [1]. Knowledge of learning or practice effects (defined as a systematic change in scores during performance of a novel exercise) should also be considered for the detection and interpretation of genuine performance changes [19].

The Wingate anaerobic test (WAnT) is the most popular method of assessing anaerobic exercise performance in athletic and general populations [3, 25]. A traditional 30 second WAnT has been shown to be valid, reliable and sensitive [5]. More recently, 6-, 10-, 20-second WAnT protocols have been proposed as shorter, effective alternatives to the 30 second WAnT [2, 10, 19, 28]. However, due to differences in sprint durations, populations and protocols direct comparisons of performance reliability between the studies should not be made.

For example, current knowledge on the performance reliability of cycle sprinting suggests that reliability data from one sprint duration should not be applied to sprints of different durations. Sprint tests of longer duration appear to be more reliable than those of shorter duration, perhaps because independent errors in individual repetitions (defined for cycle tests as individual pedal revolutions) tend to cancel themselves out as more repetitions are completed [12]. A study by Mendez-Villanueva & Bishop [19] assessed reliability of the 6 s sprint with participants sprinting in a standing position meaning the data cannot be applied when the sprint is conducted in the more common seated position [18]. Furthermore, reliability results may also differ between genders as non-athletic females appear less reliable in measures of power

than non-athletic males, possibly due to lower physical activity levels and power output (PO) [12].

Most studies conducted two trials [4, 13, 19, 21, 23], but at least one familiarisation trial is recommended for assessment of cycle sprint performance, as there is often a larger performance change between the first two trials than subsequent pairs of trials [12]. This suggests that two trials may not be sufficient to fully evaluate performance reliability or the magnitude of a practice effect.

6 s WAnT has recently been shown to be a valid measure of peak power output (PPO) compared with the 30 s WAnT [10]. However, there is currently no published data investigating the absolute and relative reliability and sensitivity of a group of males and females performing the 6 and 30 s WAnT over repeated trials.

Therefore, the aim of this study was to investigate the performance reliability and test sensitivity of the 6 and 30 s WAnT in physically active males and females. It was hypothesised that for both genders performance reliability in both sprint durations would improve following the first two trials and remain stable in subsequent trials, and that males would show better performance reliability than females across all trials.

2. Materials and methods

2.1. Subjects

Twenty healthy, physically active participants (males, n = 10, age: 24.2 ± 4.8 years, height 181 ± 4 cm, body mass (BM): 80.8 ± 6.9 kg; females, n = 10, age 22.9 ± 5.4 years, height 167 ± 6 cm, BM 66.8 ± 8.9 kg) participated in this study. Criteria for participation were to be physically active but not engaged in regular training for a specific sport, and to be

inexperienced at cycle ergometer sprinting. Participants were informed of the nature of the investigation, after which they gave written informed consent. The study was approved by the University Research Ethics Committee and conducted in accordance with the Declaration of Helsinki.

2.2. Testing procedures

Four trials were completed, each separated by 2-4 days. Within-participants, all trials were completed at the same time of day. Participants were requested to follow their normal diet for 24 h prior to the first trial and to record all food and drink consumed. This diet was replicated prior to subsequent trials. Participants were requested to fast for 2 h prior to exercise, and to refrain from strenuous exercise, alcohol and caffeine consumption for ≥ 24 h before each trial. Adherence to these procedures was verbally confirmed at each trial.

In trial 1, all equipment and procedures were explained to the participant. Height and BM wearing minimal clothing were recorded using a height stadiometer (Seca model 245, Hamburg, Germany) and digital scale (Seca model 708, Hamburg, Germany). The cycle ergometer (Monark Ergomedic 894E, Sweden) was then adjusted to fit the participant, and the seat and handlebar positions were recorded to enable the ergometer to be identically prepared for subsequent trials. A 4 min warm-up was completed against a load of 1 kg, followed by 3 x 2 s maximal cycling against a 7.5% BM load, interspersed with 45 s easy cycling [19]. The participant then dismounted the ergometer and sat for 3 min, where any questions about the upcoming test were addressed. The participant then remounted the ergometer and sat stationary with their dominant foot at the 2 o'clock position. A verbal countdown of "3, 2, 1, go" was provided, after which the participant cycled maximally. The 7.5% BM resistance was automatically added to the ergometer once cadence reached 110 rpm, and the 6 s sprint began. Vigorous verbal encouragement was provided throughout the test. On completion, the

participant cycled easily against a 1 kg resistance for 1 min, then dismounted the ergometer and sat quietly for 15 min.

Following the 15 min recovery period, the participant remounted the ergometer and completed a 30 s sprint against 7.5% BM resistance. The starting procedure was the same as that for the 6 s sprint, and vigorous verbal encouragement was provided. On completion, the participant cycled easily against a 1 kg resistance for 3 min, then dismounted the ergometer. Trials 2-4 were the same as trial 1, with the omission of the equipment introduction and height measurement. Sprint order remained the same for each trial (6 s sprint then 30 s sprint).

Participants were weighed using the same calibrated digital scale before each trial to ensure accurate resistance on the flywheel. Participants were blinded to elapsed time and cadence during sprints, and were not provided with information regarding their performance until they had completed all trials.

2.3. Measurements

For each sprint, PPO and MPO were measured. Assessment of performance reliability was the focus of the study, so no additional measurements were made. Other measurements would not have enhanced the quantification of reliability, and may have interfered with participants' preparation and/or performance during the sprints, influencing the reliability data.

2.4. Data analysis

Systematic bias in PPO and MPO for each gender was investigated using a two-way repeated measures ANOVA (trial x sprint duration). A two-way mixed model ANOVA (trial x gender) compared PPO and MPO across trials and between genders. Bonferroni corrections explored significant main effects. Cohen's *d* effect sizes were calculated for all significant post-hoc

comparisons [7]. Effect sizes (*d*) were defined as trivial (0-0.19), small (0.20 – 0.49), medium (0.50-0.79) and large (≥ 0.80) according to the scale of magnitude proposed by Cohen [7]. Statistical significance was set at $P < 0.05$.

Reliability across the four trials was expressed in terms of changes in the mean ($W \cdot kg^{-1}$ and % change). In addition, relative and absolute reliability indices were calculated using intraclass correlation coefficient (ICC) and standard error of measurement (SEM; $W \cdot kg^{-1}$ and %), respectively. The smallest worthwhile change (SWC) was determined by multiplying the smallest worthwhile effect of 0.2 (based on Cohen's *d* effect size) by the between-participant *s* [9]. This allowed interpretation of the sensitivity of the Wingate tests to detect a real performance change by comparing the SWC and SEM using thresholds from Liow and Hopkins [14]. Briefly, if the SEM is smaller than the SWC, the ability of the test to detect a change is ''good''; if the SEM equals the SWC, the test is ''satisfactory,'' and if the SEM is greater than the SWC, the test is ''marginal'' [9].

3. Results

Peak power output and MPO for males and females across all trials in both sprints are in Table 1. For males, there was no significant main effect of trial ($F_{3,27} = 2.2$, $P > 0.05$) and no interaction effect ($F_{3,27} = 0.54$, $P > 0.05$). However, there was a significant main effect of sprint duration ($F_{1,9} = 22.0$, $P < 0.05$). Peak power output in the 6 s sprint was significantly greater than the 30 s sprint across all trials ($P < 0.05$, $d = 1.86$, 1.53, 2.41, and 1.38 for trials 1-4, respectively). Similarly, there was no significant main effect of trial ($F_{3,27} = 2.3$, $P > 0.05$) or interaction ($F_{3,27} = 1.0$, $P > 0.05$) for MPO, but there was a main effect of sprint duration ($F_{1,9} = 730$, $P < 0.05$), with MPO significantly greater in the 6 s sprint than the 30 s sprint across all trials ($P < 0.05$; $d = 12.11$, 15.18, 15.44, and 18.94 for trials 1-4, respectively). For females, there was no significant main effect of trial ($F_{3,27} = 0.83$, $P > 0.05$) and no interaction effect ($F_{1.97,17.72} = 0.47$, $P > 0.05$). However, there was a significant main effect of sprint

duration ($F_{1,9}$ = 34.5, P < 0.05). Peak power output in the 6 s sprint was significantly greater than the 30 s sprint across all trials (P < 0.05, d = 1.50, 2.19, 2.71, and 1.80 for trials 1-4, respectively). There was no significant main effect of trial ($F_{3,27}$ = 0.3, P > 0.05) or interaction ($F_{1.48,13.32}$ = 1.27, P > 0.05) for MPO. However, there was a main effect of sprint duration ($F_{1,9}$ = 110.7, P < 0.05), with MPO significantly greater in the 6 s sprint than the 30 s sprint across all trials (P < 0.05, d = 5.83, 7.77, 6.84, and 7.14 for trials 1-4, respectively).

For PPO, there was a significant main effect of gender for the 6 s sprint ($F_{1,9}$ = 42.0, P < 0.05) and the 30 s sprint ($F_{1,9}$ = 43.5, P < 0.05). Peak power output was significantly greater (P < 0.05) in the males across all trials for the 6 s sprint (d = 4.05, 2.87, 2.11, and 2.56 for trials 1-4, respectively) and the 30 s sprint (d = 2.54, 2.38, 2.88, and 3.58 for trials 1-4, respectively). For MPO, there was a significant main effect of gender for the 6 s sprint ($F_{1,9}$ = 44.4, P < 0.05) and the 30 s sprint ($F_{1,9}$ = 64.1, P < 0.05). Mean power output was significantly greater (P < 0.05) in males across all trials in the 6 s sprint (d = 3.53, 2.71, 2.41, and 3.15 for trials 1-4, respectively) and the 30 s sprint (d = 3.78, 3.19, 3.26, and 3.93 for trials 1-4, respectively).

** TABLE 1 HERE **

For males, reliability statistics for each performance variable are presented in Table 2. Random variation in PPO and MPO was consistent across all trial comparisons, with ICCs ≥ 0.89 and SEM ≤ 3.9% in all comparisons. For females, reliability statistics for each performance variable are in Table 3. Random variation for PPO in the 6 and 30 s sprints was notably lower in trial 3-4 compared with the earlier pairs of trials, suggesting improvement in PPO reliability across trials. Mean power output between trials in the 6 s sprint was variable, with the smallest variation occurring between trials 1-2. For the 30 s sprint, MPO was more stable across trials.

For males, the test sensitivity of the Wingate test was rated good for MPO in trials 1-2, and satisfactory for trials 3-4, for the 30 s test. For all other pairwise comparisons, test sensitivity was marginal. For females, test sensitivity was good for PPO between trials 3-4 in the 6 s test, and for MPO between trials 2-3 in the 30 s test. Test sensitivity was marginal for all other pairwise comparisons. When test sensitivity was assessed across all four trials, only MPO in the 30 s Wingate test for males displayed good test sensitivity (Tables 2 & 3).

** TABLE 2 HERE**

** TABLE 3 HERE **

4. Discussion

There was no clear and consistent difference in performance reliability between trials 1-2 and subsequent pairs of trials across sprints for either gender. Therefore, the first hypothesis is rejected. Males demonstrated smaller random variation in performance across trials in both sprint durations, therefore the second hypothesis is accepted. However, the sensitivity of both tests to detect the SWC was generally marginal for both genders.

There were no significant changes in PPO or MPO across all trials for both sprint durations in males and females (Table 1). In contrast, previous studies reported significant increases in PPO and MPO between trials 1-2 [4, 19, 26]. However, Mendez-Villanueva and Bishop [19] assessed reliability of the 6 s Wingate performed in a standing position, and Secrest et al. [26] recruited a small female sample (n = 5) that would have limited the veracity of the statistical analyses. Other work has reported no significant practice effects for cycle sprints lasting ~5-30 s [9, 13, 21], indicating that familiarisation is not always required for achievement of stable performance. Performance reliability can be influenced by many factors including training

status, time between trials, ergometer quality, and participant-specific characteristics [12], which may help to explain conflicting findings regarding the presence of a practice effect.

No significant difference in PPO or MPO across trials for females appears to refute the suggestion that females may be less reliable than males [12]. However, females demonstrated a notably lower random variation for PPO in trials 3-4 of the 6 and 30 s sprints. Therefore, it may be useful to familiarise females to Wingate testing if the aim is to detect genuine mean changes in PPO between trials. Females also demonstrated more between-trials error in PO measures than males.

Participants in the current study recorded significantly greater PPO in the 6 s sprint than the 30 s sprint across all trials (Table 1). Lower PPO in the 30 s sprints was probably not due to residual fatigue from having undertaken the 6 s sprint ~15 min earlier, as pilot work confirmed that 15 minute rest was sufficient to recover from the 6 s sprint before performing the 30 s sprint. Lower PPO in the 30 s trials may be evidence of a pacing strategy. Previous work has shown dampened PO and reduced fatigue index in the first 15 s of a 30 s cycle sprint compared with a 15 s sprint [27], suggesting that people only exert their true maximal cycling power when test duration is < 30 s [15]. The current study appears to be the first to demonstrate significant differences in PPO between sprint durations of 6 and 30 s.

Test sensitivity of both sprint durations was generally marginal (Tables 2 & 3). Athletic participants appear to be more reliable in measures of PO than non-athletic participants [12]. Participants in the current study were physically active, but not training for a specific sport or experienced at cycle sprinting. Therefore, these participants may have demonstrated sufficiently large within-participant performance variation that, while not affecting actual PO measures across trials at the group mean level, did lead to larger within-participant variability (SEM), thereby impacting on test sensitivity. It would have been interesting to investigate this further by replicating the analysis of McLellan et al. [17] and splitting participants into “high

variability" and "low variability" cohorts. Unfortunately, sample sizes were not sufficient to take this approach.

Males recorded significantly greater PPO and MPO than females across all trials for both sprint durations (Table 1). This finding was expected, as it has been consistently demonstrated that males produce significantly greater absolute and BM-relative PPO and MPO than females during Wingate tests [8, 22]. While scaling PO to other anthropometric values, such as lean BM, can significantly reduce or negate this gender difference [24], the purpose of the current study was not to evaluate gender differences in PO. Therefore, additional scaling was not undertaken.

From a practical standpoint, no significant difference in PPO or MPO across trials for the 6 and 30 s Wingate tests in males and females suggests that researchers or practitioners using these tests to evaluate performance may not need to employ a familiarisation to control for practice effects. However, the mostly marginal test sensitivity in both sprint durations for both genders highlights another important practical application. Using a physically active sample unfamiliar with cycle sprinting to assess a performance intervention using the Wingate 6 or 30 s test may not provide sufficient sensitivity to quantify the ability of the intervention to make a worthwhile change. Therefore, if attempting to judge the potential use of an intervention in a particular population, for example trained athletes, it is important to move beyond convenience sampling to recruit participants that reflect as closely as possible the population that the intervention aims to target. Failure to do so may result in the intervention being incorrectly discarded due to lack of efficacy. If the recruited sample does not adequately reflect the target population, caution should be used when extrapolating results of interventions that use the 6 or 30 s Wingate test as the performance measure.

One potential limitation of this study is that menstrual cycle stage was not documented, which may have affected the results. However, the influence of the menstrual cycle on PO in females is contentious and evidence suggests that menstrual cycle staging has no significant

effect on cycle sprint performance [6, 16, 20]. Additionally, completion of the 6 and 30 s sprints on separate days would have allowed the order of the sprints to be randomised. Finally, time of day of testing was not consistent between-subjects for logistical reasons; however, it was consistent within-subjects.

5. Conclusion

In conclusion, no significant difference in PPO or MPO was observed across four trials of a 6 and 30 s Wingate test in physically active males and females, indicating that familiarisation may not be required to establish consistent performance. However, the lower random variation in PPO between the final two trials for both sprint durations in females suggests familiarisation may be useful for females if the goal of testing is to detect genuine mean changes in PPO. In this physically active, non-cycle sprint habituated sample, the sensitivity of the 6 and 30 s Wingate tests to detect smallest worthwhile changes in PPO and MPO was generally marginal.

6. Conflict of interest

No funding was received for this study. The authors have no conflict of interest and will not benefit, financially or otherwise, by the publication of this work.

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Tables

Table 1. Peak power output and mean power output for males and females in all trials for the 6 s and 30 s sprints. Data are mean ± SD.

	Trial 1	Trial 2	Trial 3	Trial 4
6 s PPO ($W \cdot kg^{-1}$)				
Male	14.21 ± 1.64*^	14.29 ± 1.58*^	14.69 ± 1.61*^	14.27 ± 1.53*^
Female	10.49 ± 1.38**	10.69 ± 1.52**	10.94 ± 2.14**	10.53 ± 2.10**
6 s MPO ($W \cdot kg^{-1}$)				
Male	12.17 ± 0.88*^	12.32 ± 1.02*^	12.51 ± 1.05*^	12.37 ± 0.91*^
Female	9.43 ± 1.27**	9.56 ± 1.20**	9.53 ± 1.65**	9.31 ± 1.56**
30 s PPO ($W \cdot kg^{-1}$)				
Male	13.04 ± 1.70^	13.39 ± 1.78^	13.75 ± 1.57^	13.40 ± 1.52^
Female	9.76 ± 1.43	9.78 ± 1.42	9.89 ± 1.73	9.67 ± 1.52
30 s MPO ($W \cdot kg^{-1}$)				
Male	8.84 ± 0.59^	8.82 ± 0.61^	8.93 ± 0.59^	8.89 ± 0.59^
Female	6.93 ± 0.81	6.80 ± 0.77	6.89 ± 0.79	6.88 ± 0.71

** Significantly greater than the same trial for the 30 s sprint (male data); ** Significantly greater than the same trial for the 30 s sprint (female data); ^ Significantly greater than the corresponding female data.*

Table 2. Pairwise reliability and smallest worthwhile change for peak power output and mean power output during the 6 and 30 s sprints for the male participants.

	Trial	Δ Mean ($W \cdot kg^{-1}$)	Δ Mean (%)	ICC	SEM ($W \cdot kg^{-1}$)	SEM (%)	SWC ($W \cdot kg^{-1}$)
6 s PPO	1 to 2	0.08	0.75	0.92	± 0.53	3.9	0.32
		(-0.45 to 0.62)	(-2.57 to 4.07)	(0.71 to 0.98)	(0.37 to 0.97)	(2.6 to 7.2)	
	2 to 3	0.39	2.86	0.95	± 0.43	3.0	0.32
		(-0.04 to 0.82)	(0.24 to 5.48)	(0.80 to 0.99)	(0.29 to 0.78)	(2.0 to 5.5)	
	3 to 4	-0.42	-2.69	0.92	± 0.52	3.6	0.31
		(-0.94 to 0.11)	(-5.70 to 0.32)	(0.70 to 0.98)	(0.36 to 0.95)	(2.5 to 6.6)	
	All Trials	0.02	0.31	0.93	± 0.49	3.5	0.32
		(-0.48 to 0.52)	(-3.13 to 3.75)	(0.81 to 0.98)	(0.38 to 0.71)	(2.7 to 5.0)	
6 s MPO	1 to 2	0.15	1.22	0.94	± 0.28	2.4	0.19
		(-0.13 to 0.43)	(-0.84 to 3.28)	(0.76 to 0.98)	(0.19 to 0.51)	(1.6 to 4.4)	
	2 to 3	0.19	1.55	0.94	± 0.30	2.5	0.21
		(-0.12 to 0.49)	(-0.63 to 3.73)	(0.77 to 0.98)	(0.21 to 0.55)	(1.7 to 4.6)	
	3 to 4	-0.14	-0.93	0.89	± 0.36	2.9	0.20
		(-0.50 to 0.23)	(-3.32 to 1.46)	(0.63 to 0.97)	(0.25 to 0.66)	(2.0 to 5.3)	
	All Trials	0.07	0.61	0.92	± 0.32	2.6	0.20

		(-0.24 to 0.38)	(-1.94 to 3.16)	(0.79 to 0.98)	(0.24 to 0.45)	(2.0 to 3.7)	
30 s	1 to 2	0.34	2.71	0.93	± 0.52	3.7	0.35
PPO		(-0.19 to 0.87)	(-0.44 to 5.86)	(0.75 to 0.98)	(0.36 to 0.96)	(2.5 to 6.8)	
	2 to 3	0.36	3.03	0.96	± 0.41	3.2	0.34
		(-0.06 to 0.78)	(0.23 to 5.83)	(0.83 to 0.99)	(0.28 to 0.75)	(2.2 to 5.9)	
	3 to 4	-0.34	-2.40	0.94	± 0.45	3.4	0.31
		(-0.80 to 0.11)	(-5.21 to 0.41)	(0.77 to 0.98)	(0.31 to 0.82)	(2.3 to 6.3)	
	All Trials	0.12	1.11	0.94	± 0.46	3.4	0.33
		(-0.34 to 0.58)	(-2.26 to 4.48)	(0.84 to 0.98)	(0.36 to 0.66)	(2.6 to 4.9)	
30 s	1 to 2	-0.02	-0.25	0.99	± 0.08	0.9	0.12†
MPO		(-0.10 to 0.06)	(-1.07 to 0.57)	(0.95 to 1.00)	(0.06 to 0.15)	(0.6 to 1.7)	
	2 to 3	0.11	1.33	0.97	± 0.13	1.4	0.12
		(-0.01 to 0.24)	(0.06 to 2.60)	(0.87 to 0.99)	(0.09 to 0.23)	(1.0 to 2.7)	
	3 to 4	-0.05	-0.53	0.97	± 0.12	1.4	0.12†
		(-0.17 to 0.07)	(-1.70 to 0.64)	(0.89 to 0.99)	(0.08 to 0.21)	(0.9 to 2.5)	
	All Trials	0.01	0.18	0.97	± 0.11	1.3	0.12†
		(-0.10 to 0.12)	(-1.08 to 1.44)	(0.93 to 0.99)	(0.08 to 0.16)	(1.0 to 1.18)	

ICC = intraclass correlation coefficient; SEM = standard error of measurement; SWC = smallest worthwhile change; † indicates that test sensitivity is good (SEM < SWC) or satisfactory (SEM = SWC); Values in parentheses are 95% confidence limits.

Table 3. Pairwise reliability and smallest worthwhile change for peak power output and mean power output during the 6 and 30 s sprints for the female participants.

	Trial	Δ Mean ($W \cdot kg^{-1}$)	Δ Mean (%)	ICC	SEM ($W \cdot kg^{-1}$)	SEM (%)	SWC ($W \cdot kg^{-1}$)
6 s	1 to 2	0.20	1.97	0.87	± 0.59	6.0	0.29
PPO		(-0.40 to 0.80)	(-3.2 to 7.14)	(0.56 to 0.97)	(0.41 to 1.09)	(4.1 to 11.2)	
	2 to 3	0.26	1.76	0.93	± 0.55	5.1	0.37
		(-0.30 to 0.81)	(-2.63 to 6.15)	(0.76 to 0.98)	(0.38 to 1.01)	(3.5 to 9.5)	
	3 to 4	-0.42	-3.76	0.97	± 0.40	4.1	0.42†
		(-0.82 to -0.02)	(-7.06 to -0.46)	(0.90 to 0.99)	(0.27 to 0.73)	(2.8 to 7.6)	
	All Trials	0.01	-0.01	0.94	± 0.52	5.1	0.36
		(-0.51 to 0.53)	(-4.96 to 4.94)	(0.84 to 0.98)	(0.40 to 0.75)	(3.9 to 7.4)	
6 s	1 to 2	0.14	1.63	0.97	± 0.26	2.7	0.25
MPO		(-0.12 to 0.40)	(-0.69 to 3.95)	(0.88 to 0.99)	(0.18 to 0.47)	(1.8 to 4.9)	
	2 to 3	-0.04	-0.90	0.94	± 0.42	5.0	0.29
		(-0.46 to 0.39)	(-5.02 to 3.22)	(0.77 to 0.98)	(0.29 to 0.77)	(3.4 to 9.2)	
	3 to 4	-0.21	-2.03	0.97	± 0.34	4.1	0.32
		(-0.55 to 0.13)	(-5.45 to 1.39)	(0.88 to 0.99)	(0.23 to 0.61)	(2.8 to 7.6)	
	All Trials	-0.04	-0.43	0.96	± 0.35	4.0	0.29

		(-0.38 to 0.30)	(-4.23 to 3.37)	(0.89 to 0.99)	(0.27 to 0.49)	(3.1 to 5.8)	
30 s	1 to 2	0.02	0.63	0.89	± 0.55	5.7	0.29
PPO		(-0.53 to 0.58)	(-4.08 to 5.34)	(0.61 to 0.97)	(0.38 to 1.00)	(3.9 to 10.6)	
	2 to 3	0.10	0.89	0.88	± 0.61	6.5	0.32
		(-0.51 to 0.72)	(-4.68 to 6.46)	(0.60 to 0.97)	(0.42 to 1.12)	(4.4 to 12.2)	
	3 to 4	-0.22	-1.77	0.96	± 0.39	4.1	0.33
		(-0.61 to 0.17)	(-5.19 to 1.65)	(0.84 to 0.99)	(0.27 to 0.70)	(2.8 to 7.5)	
	All Trials	-0.03	-0.08	0.91	± 0.52	5.5	0.31
		(-0.55 to 0.49)	(-5.36 to 5.20)	(0.78 to 0.97)	(0.40 to 0.75)	(4.2 to 8.0)	
30 s	1 to 2	-0.12	-1.67	0.95	± 0.21	3.1	0.16
MPO		(-0.34 to 0.09)	(-4.27 to 0.93)	(0.80 to 0.99)	(0.15 to 0.39)	(2.1 to 5.7)	
	2 to 3	0.09	1.25	0.98	± 0.13	2.0	0.16†
		(-0.05 to 0.22)	(-0.47 to 2.97)	(0.92 to 0.99)	(0.09 to 0.24)	(1.3 to 3.6)	
	3 to 4	-0.01	0.07	0.96	± 0.17	2.6	0.15
		(-0.18 to 0.16)	(-2.17 to 2.31)	(0.86 to 0.99)	(0.12 to 0.31)	(1.8 to 4.7)	
	All Trials	-0.02	-0.12	0.96	± 0.17	2.6	0.16
		(-0.19 to 0.15)	(-2.64 to 2.40)	(0.90 to 0.99)	(0.13 to 0.25)	(2.0 to 3.7)	

ICC = intraclass correlation coefficient; SEM = standard error of measurement; SWC = smallest worthwhile change; Values in parentheses are 95% confidence limits.